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(54) SEMICONDUCTOR DEVICE, REFLECTION TYPE LIQUID CRYSTAL DISPLAY DEVICE, AND REFLECTION TYPE LIQUID CRYSTAL PROJECTOR

HALBLEITERBAUELEMENT, FLÜSSIGKRISTALLANZEIGEBAUELEMENT DES REFLEXIONSTYPS UND FLÜSSIGKRISTALLPROJEKTOR DES REFLEXIONSTYPS

DISPOSITIF A SEMI-CONDUCTEUR, DISPOSITIF D'AFFICHAGE A CRISTAUX LIQUIDES A REFLEXION ET PROJECTEUR A CRISTAUX LIQUIDES A REFLEXION

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EP 1 513 005 B1

Description

Technical Field

[0001] The present invention relates to a semiconductor device for constituting an active matrix drive portion in a reflection type liquid crystal display apparatus for active matrix display, a reflection type liquid crystal display apparatus for active matrix display, and a reflection type liquid crystal projector using a reflection type liquid crystal display apparatus for active matrix display.

Background Art

[0002] As a reflection type liquid crystal display apparatus for active matrix display, the one shown in Fig. 7 has been considered.

[0003] The reflection type liquid crystal display apparatus 9 is comprised, as a whole, of a liquid crystal layer 33 formed by injecting a liquid crystal between a semiconductor device portion 50 constituting an active matrix drive portion and a counter transparent substrate 32 provided with a counter transparent electrode 31 functioning in common for each pixel.

[0004] The semiconductor device portion 50 comprises a semiconductor substrate (semiconductor base) 11 such as a silicon substrate of a first conduction type, for example, P type, on which switching transistors 13 and signal accumulation capacitors 55 are provided on the basis of each unit region for constituting a pixel Px.

[0005] The switching transistor 13 is configured as a MIS (Metal Insulator Semiconductor) type or MOS (Metal Oxide Semiconductor) type transistor in which a source region 13S and a drain region 13D of a second conduction type (namely, of N type where the semiconductor substrate 11 is of P type) are formed in the semiconductor substrate 11, and a gate electrode 13G formed of polysilicon or the like is formed on the region between the source region 13S and the drain region 13D, with a thin insulating layer 12a therebetween which constitutes a part of an insulating layer 12 formed of silicon dioxide or the like.

[0006] The signal accumulation capacitor 55 is configured as a MIS type or MOS type transistor in which semiconductor regions 55D and 55S of the same second conduction type as that of the source region 13S and the drain region 13D of the switching transistor 13 (namely, of N type where the semiconductor substrate 11 is of P type) are formed in the semiconductor substrate 11, and an electrode 55G is formed on the region between the semiconductor regions 55D and 55S, with a thin insulating layer 12b therebetween which constitutes a part of the insulating layer 12. With an appropriate potential impressed on the semiconductor regions 55D and 55S, a channel 55c is formed at a portion beneath the electrode 55G between the semiconductor regions 55D and 55S, and a capacitance is formed.

[0007] Furthermore, high-concentration bias semiconductor regions 57 of the same first conduction type as that of the semiconductor substrate 11 (namely, of P type where the semiconductor substrate 11 is of P type), for impressing a bias potential such as earth potential on the semiconductor substrate 11, are formed in the semiconductor substrate 11 on the basis of each unit region constituting a pixel Px.

[0008] In addition, on an insulating layer 14 formed on the insulating layer 12, a scan line (scan electrode) 21 is formed in connection with the gate electrode 13G of the switching transistor 13, a signal line (signal electrode) 23 is formed in connection with the source region 13S of the switching transistor 13, a wiring 25 is formed for interconnection between the drain region 13D of the switching transistor 13 and the electrode 55G of the signal accumulation capacitor 55, and a bias electrode 59 is formed in connection with the semiconductor regions 55D and 55S of the signal accumulation capacitor 55 and with the bias semiconductor region 57.

[0009] Furthermore, on an insulating layer 16 formed on the insulating layer 14, a reflection electrode 19 for constituting a pixel electrode is formed in connection with the wiring 25, i.e., in connection with the drain region 13D of the switching transistor 13 and the electrode 55G of the signal accumulation capacitor 55.

[0010] The reflection type liquid crystal display apparatus 9 has a structure in which a multiplicity of the scan lines 21 are arranged in a vertical direction of a display screen, a multiplicity of the signal lines 23 are arranged in a horizontal direction of the display screen, and each of the portions at intersections of the scan lines 21 and the signal lines 23 is constituted as the pixel Px as abovementioned.

[0011] With the bias electrode 59 earthed, an earth potential impressed on the semiconductor regions 55D and 55S of the signal accumulation capacitor 55 and the bias semiconductor region 57, and with a predetermined potential impressed on the counter transparent electrode 31 functioning in common for each pixel, the scan lines 21 are sequentially selected by a scan line drive circuit, and a predetermined potential is impressed on the gate electrode 13G of the switching transistor 13 for the pixel connected to the scan line 21 thus selected, whereby the switching transistor 13 for the pixel under consideration is turned ON, and a signal voltage is impressed on the source region 13S of the switching transistor 13 for the pixel in consideration through the signal line 23 by a signal line drive circuit, whereby a signal charge is accumulated in the capacitance of the signal accumulation capacitor 55 for the pixel under consideration through the drain region 13D of the switching transistor 13 for the pixel under consideration.

[0012] The signal charge thus accumulated is impressed on the reflection electrode 19 for the pixel under consideration, an electric field according to the signal voltage is impressed between the counter transparent electrode 31 functioning in common for each pixel and the reflection electrode 19 for the pixel under consider-

ation, and, according to this, the rotatory polarization of light at the portion of the pixel under consideration is controlled by the liquid crystal layer 33. Then, the light which is incident on the reflection type liquid crystal display apparatus 9 from the outside of the counter transparent substrate 32, is transmitted through the portion of the pixel under consideration of the liquid crystal layer 33, is reflected by the reflection electrode 19, is again transmitted through the portion of the pixel under consideration of the liquid crystal layer 33 and goes out to the outside of the counter transparent substrate 32 is modulated, and the light in a predetermined polarization direction is transmitted, whereby an image is displayed on the reflection type liquid crystal display apparatus 9.

[0013] However, in the semiconductor device portion 50 in the reflection type liquid crystal display apparatus 9 according to the related art shown in Fig. 7 and described above, the semiconductor regions 55D and 55S constituting the signal accumulation capacitor 55 are of a conduction type different from that of the semiconductor substrate (semiconductor base) 11, i.e., they are of the same conduction type as that of the source region 13S and the drain region 13D of the switching transistor 13. Therefore, for separation between the switching transistor region and the signal accumulation capacitor region, the distance between the switching transistor region and the signal accumulation capacitor region, i.e., the distance d between the drain region 13D of the switching transistor 13 and the semiconductor region 55D of the signal accumulation capacitor 55 must be large at least to a certain extent. As a result, the area of the pixel Px is large, and the number of pixels which can be formed in a predetermined size is small.

[0014] In addition, since the semiconductor regions 55D and 55S constituting the signal accumulation capacitor 55 are of a conduction type different from that of the semiconductor substrate (semiconductor base) 11, the bias semiconductor region 57 of the same conduction type as that of the semiconductor substrate 11, for impressing a bias potential such as an earth potential on the semiconductor substrate 11, must be formed in the semiconductor substrate 11; accordingly, the area of the pixel Px is enlarged and the number of pixels which can be formed in a predetermined size is reduced.

[0015] When the area of the bias semiconductor region 57 is reduced for minimizing the enlargement of the area of the pixel Px, a bias potential cannot be stably impressed on the semiconductor substrate 11, and noise resistance is degraded.

[0016] Accordingly, the present invention aims at realizing a reduction in the area of a pixel without degrading noise resistance.

[0017] JP 055 164 875 A discloses another type of semiconductor device. According to said document, where is provided a P-type semiconductor substrate having a P-type capacitance region 13 and an N-type drain region and source region 11. 12 forming a transistor. The capacitor is connected to a power (voltage) source line 15. However, that document does not disclose a connection of the capacitor to a bias electrode.

[0018] Another type of semiconductor device is shown and described in JP 10 039332 A. As mentioned therein, conductive layers which constitute holding capacitors are formed by each of respective pixels below pixel electrodes which are reflection electrodes. Semiconductor regions or other conductive layers which constitute the other terminals of the holding capacitors are formed via insulating films below or above the conductive layers. The conductive layers are electrically connected to transistors for driving the pixel electrodes. The semiconductor regions are electrically connected to wiring layers which are connected to a LC common voltage applied from an opposite substrate.

[0019] Still another Semiconductor device is disclosed in US-A-6 133 976. According to said document, picture element electrodes of a spatial light modulation device are located in the form of a two-dimensional matrix, an opposite electrode being located at a spacing from the picture element electrodes, and a light modulation layer being located between the opposite electrode and the picture element electrodes. An insulation film is formed between the light modulation layer and the picture element electrodes. An electrically conductive film is formed with the insulation film intervening between the electrically conductive film and the picture element electrodes, and covers at least a portion of a gap between adjacent picture element electrodes.

[0020] The active-matrix substrate described in US-A-6 133 976 differs from that defined in appended claim 1 at least in that its signal accumulation capacitor has only one semiconductor region provided in the semiconductor base and that said one semiconductor region of the signal accummulation capacitor is not connected to a bias electrode.

[0021] JP 61 119072 A shows a semiconductor capacity device which teaches to prevent the generation of a parasitic capacity between an n^+ diffusion part and a substrate by separating the n^+ diffusion part from the substrate by arranging it in an n type well.

[0022] JP 10 293323 discloses a liquid crystal panel with a transistor being comprised of a source zone and a drain zone made of a high impurity introduction layer formed on a substrate surface at both sides of a gate electrode. Moreover, there is also formed a storage capacitor. There is a disadvantage of the state of the art that the contact regions for the substate are sensitive for noise carried on the substrate.

[0023] It is an object of the present invention to realize a reduction in the area of a pixel without degrading noise resistance.

[0024] This object is achieved by a semiconductor device according to independent claim 1. Preferred embodiments are given in the dependent claims.

[0025] In the semiconductor device according to appended claim 1, the semiconductor regions for constituting the signal accumulation capacitor are of the same

conduction type as that of the semiconductor base, i.e., of a conduction type different from that of the source region and the drain region of the switching transistor. Therefore, for separation between the switching transistor region and the signal accumulation capacitor region, the distance between the switching transistor region and the signal accumulation capacitor region, i.e., the distance between the drain region of the switching transistor and the semiconductor region on the switching transistor side of the signal accumulation capacitor can be made to be sufficiently small, whereby the area of the pixel can be reduced, and the number of pixels which can be formed in a predetermined size can be enlarged.

[0026] In this case, the reduction in the area of the pixel can be realized in the same manner as above also by forming a bias semiconductor region of the first conduction type on the semiconductor base, separately from the semiconductor regions for constituting the signal accumulation capacitor, as defined in appended dependent claim 2. Since the semiconductor region for constituting the signal accumulation capacitor is of the same conduction type as that of the semiconductor base, the semiconductor regions for constituting the signal accumulation capacitor are made to serve also as bias semiconductor regions of the semiconductor base, and therefore, the area of the pixel can be further reduced, and the number of pixels which can be formed in a predetermined size can be further enlarged.

[0027] In addition, according to the present invention, there is provided a reflection type liquid crystal display apparatus according to appended claim 3.

[0028] Furthermore, according to the present invention, there is provided a reflection type liquid crystal projector according to appended claim 4.

Brief Description of Drawings

[0029]

Fig. 1 is a sectional view showing a first embodiment of a reflection type liquid crystal display apparatus according to the present invention.

Fig. 2 is a sectional view showing a second embodiment of the reflection type liquid crystal display apparatus according to the present invention.

Fig. 3 is a sectional view showing a reflection type liquid crystal display apparatus useful for understanding the present invention.

Fig. 4 is a perspective view showing a general configuration of the reflection type liquid crystal display apparatus according to the present invention.

Fig. 5 is a connection view showing a circuit configuration of the reflection type liquid crystal display apparatus according to the present invention.

Fig. 6 illustrates an embodiment of a reflection type liquid crystal projector according to the present invention.

Fig. 7 is a sectional view showing a reflection type liquid crystal display apparatus according to the related art.

Best Mode for Carrying Out the Invention

[Embodiments of Semiconductor Device and Reflection Type Liquid Crystal Display Apparatus: Figs. 1, 2, 4, 5]

<First Embodiment: Fig. 1>

[0030] Fig. 1 illustrates a first embodiment of the reflection type liquid crystal display apparatus according to the present invention which comprises as a semiconductor device portion a first embodiment of the semiconductor device according to the present invention.

[0031] The reflection type liquid crystal display apparatus 1 according to this embodiment has, as a whole, a configuration in which a liquid crystal layer 33 is formed by injecting a liquid crystal between a semiconductor device portion 10 for constituting an active matrix drive portion and a counter transparent substrate 32 provided with a counter transparent electrode 31 functioning in common for each pixel.

[0032] The semiconductor device portion 10 has a configuration in which a switching transistor 13 and a signal accumulation capacitor 15 are formed on a semiconductor substrate (semiconductor base) 11 such as a silicon substrate of a first conduction type, for example, P type, on the basis of each unit region for constituting a pixel Px.

[0033] The switching transistor 13 is constituted as a MIS type or MOS type transistor in which a source region 13S and a drain region 13D of a second conduction type (namely, of N type where the semiconductor substrate 11 is of P type) are formed in the semiconductor substrate 11, and a gate electrode 13G formed of polysilicon or the like is formed on the region between the source region 13S and the drain region 13D, with a thin insulating layer 12a therebetween which constitutes a part of an insulating layer 12 formed of silicon dioxide or the like.

[0034] The signal accumulation capacitor 15 is constituted as a MIS type or MOS type transistor in which high-concentration semiconductor regions 15D and 15S of the same first conduction type as that of the semiconductor substrate 11 (namely, of P type where the semiconductor substrate 11 is of P type) are formed in the semiconductor substrate 11, and an electrode 15G is formed on the region between the semiconductor regions 15D and 15S, with a thin insulating layer 12b therebetween which constitutes a part of the insulating layer 12. With an appropriate potential impressed on the semiconductor regions 15D and 15S, a channel 15c is formed at a portion beneath the electrode 15G between the semiconductor regions 15D and 15S, and a capacitance is formed.

[0035] In this embodiment, further, a high-concentration bias semiconductor region 17 of the same first conduction type as that of the semiconductor substrate 11 (namely, of P type where the semiconductor substrate 11 is of P type), for impressing a bias potential such as

an earth potential on the semiconductor substrate 11, is formed in the semiconductor substrate 11 on the basis of each unit region for constituting the pixel Px.

[0036] Besides, on an insulating layer 14 formed on the insulating layer 12, a scan line (scan electrode) 21 is formed in connection with the gate electrode 13G of the switching transistor 13, a signal line (signal electrode) 23 is formed in connection with the source region 13S of the switching transistor 13, a wiring 25 is formed for interconnection between the drain region 13D of the switching transistor 13 and the electrode 15G of the signal accumulation capacitor 15, and a bias electrode 27 is formed in connection with the semiconductor regions 15D and 15S of the signal accumulation capacitor 15 and the bias semiconductor region 17.

[0037] Furthermore, on an insulating layer 16 formed on the insulating layer 14, a reflection electrode 19 for constituting a pixel electrode is formed in connection with the wiring 25, i.e., in connection with the drain region 13D of the switching transistor 13 and the electrode 15G of the signal accumulation capacitor 15.

[0038] As shown in Fig. 4, the reflection type liquid crystal display apparatus 1 has a configuration in which a multiplicity of scan lines 21 are arranged in a vertical direction of a display screen, a multiplicity of signal lines 23 are arranged in a horizontal direction of the display screen, and the portion of each of the intersections of the scan lines 21 and the signal lines 23 is constituted as a pixel Px as above-described.

[0039] As shown in Fig. 5, a drive circuit is so constituted that with the bias electrodes 27 earthed, with the earth potential impressed on the semiconductor regions 15D and 15S of the signal accumulation capacitors 15 and the bias semiconductor regions 17, and with a predetermined potential impressed on the counter transparent electrode 31 functioning in common for each pixel, the scan lines 21 are sequentially selected by a scan line drive circuit, and a predetermined potential is impressed on the gate electrode 13G of the switching transistor 13 for the pixel connected to the scan line 21 thus selected, whereby the switching transistor 13 for the pixel under consideration is turned ON, and a signal voltage is impressed on the source region 13S of the switching transistor 13 for the pixel under consideration through the signal line 23 by a signal line drive circuit, whereby a signal charge is accumulated in the capacitance of the signal accumulation capacitor 15 for the pixel under consideration through the drain region 13D of the switching transistor 13 for the pixel under consideration.

[0040] The signal charge thus accumulated is impressed on the reflection electrode 19 for the pixel under consideration, and an electric field according to the signal voltage is impressed between the counter transparent electrode 31 functioning in common for each pixel and the reflection electrode 19 for the pixel under consideration. According to this, the rotatory polarization state of the liquid crystal at the portion of the pixel under consideration having a liquid crystal capacity Cx of the liquid crystal layer 33 is controlled, and the light which is incident on the reflection type liquid crystal display apparatus 1 from the outside of the counter transparent substrate 32, is transmitted through the portion of the pixel under consideration of the liquid crystal layer 33, is reflected by the reflection electrode 19, is again transmitted through the portion of the pixel under consideration of the liquid crystal layer 33 and goes out to the outside of the counter transparent substrate 32 is modulated, and the light in a predetermined polarization direction is outputted, whereby an image is displayed on the reflection type liquid crystal display apparatus 1.

[0041] In the reflection type liquid crystal display apparatus 1 and the semiconductor device portion 10 according to the embodiment shown in Fig. 1, the semiconductor regions 15D and 15S for constituting the signal accumulation capacitor 15 are of the same conduction type as that of the semiconductor substrate (semiconductor base) 11, i.e., of the conduction type different from that of the source region 13S and the drain region 13D of the switching transistor 13. Therefore, for separation between the switching transistor region and the signal accumulation capacitor region, the distance between the switching transistor region and the signal accumulation capacitor region, i.e., the distance d between the drain region 13D of the switching transistor 13 and the semiconductor region 15D. of the signal accumulation capacitor 15 can be made to be sufficiently small, whereby the area of the pixel Px can be reduced, and the number of pixels which can be formed in a predetermined size can be enlarged.

[0042] Moreover, not only the bias semiconductor region 17 but also the semiconductor regions 15D and 15S for constituting the signal accumulation capacitors 15 are used as the regions for impressing the bias potential on the semiconductor substrate 11; accordingly, the bias potential is stably impressed on the semiconductor substrate 11, and noise resistance is enhanced.

[0043] Incidentally, a bias potential different from the earth potential may be impressed on the semiconductor regions 15D and 15S of the signal accumulation capacitor 15 and the bias semiconductor region 17.

[0044] Besides, on the contrary to the embodiment shown in Fig. 1, the semiconductor substrate (semiconductor base) 11, the semiconductor regions 15D and 15S of the signal accumulation capacitor 15 and the bias semiconductor region 17 may be of N type, while the source region 13S and the drain region 13D of the switching transistor 13 may be of P type.

[0045] Furthermore, instead of using the semiconductor substrate directly as the semiconductor base and forming the source region and the drain region of the switching transistor, the semiconductor regions for constituting the signal accumulation capacitor, and the bias semiconductor region in the semiconductor base, a configuration may be adopted in which, for example, a semiconductor base of P type is formed on a semiconductor substrate of N type, and a source region and a drain

region of N type for constituting the switching transistor, a semiconductor region of P type for constituting the signal accumulation capacitor, and a bias semiconductor region of P type are formed in the semiconductor base of the P type.

<Second Embodiment: Fig. 2>

[0046] Fig. 2 illustrates a second embodiment of the reflection type liquid crystal display apparatus according to the present invention which comprises as a semiconductor device portion a second embodiment of the semiconductor device according to the present invention.

[0047] In this embodiment, in the case of forming the switching transistor 13 and the signal accumulation capacitor 15 on the semiconductor substrate (semiconductor base) 11 as in the embodiment shown in Fig. 1, a bias semiconductor region is not formed in the semiconductor substrate 11 separately from the high-concentration semiconductor regions 15D and 15S of the same conduction type as that of the semiconductor substrate 11 for constituting the signal accumulation capacitor 15, and, instead, the semiconductor regions 15D and 15S for constituting the signal accumulation capacitor 15 are made to serve also as the bias semiconductor region for impressing the bias potential on the semiconductor substrate 11.

[0048] Besides, a bias electrode 27 is formed on the insulating layer 14 in the state of being connected to the semiconductor regions 15D and 15S, and the bias electrode 27 is connected to a bias potential point such as an earth potential point, whereby a bias potential such as the earth potential is impressed on the semiconductor regions 15D and 15S. The other aspects are the same as in the embodiment shown in Fig. 1.

[0049] Therefore, in the embodiment shown in Fig. 2, like in the embodiment shown in Fig. 1, for separation between the switching transistor region and the signal accumulation capacitor region, the distance between the switching transistor region and the signal accumulation capacitor region, i.e., the distance between the drain region 13D of the switching transistor 13 and the semiconductor region 15D of the signal accumulation capacitor 15 can be made to be sufficiently small. In addition, the portion for forming the bias semiconductor region 17 in the embodiment shown in Fig. 1 can be cut from the pixel region. Therefore, as compared with the embodiment shown in Fig. 1, the area of the pixel Px can be further reduced, and the number of pixels which can be formed in a predetermined size can be further enlarged.

[0050] Moreover, the area of the pixel Px can be made to be sufficiently small, even without reducing the area of the semiconductor regions 15D and 15S of the signal accumulation capacitor 15 serving also as the bias semiconductor region. As a result, the bias potential is stably impressed on the semiconductor substrate 11, and noise resistance is enhanced.

[0051] Incidentally, on the contrary to the embodiment shown in Fig. 2, the semiconductor substrate (semiconductor base) 11 and the semiconductor regions 15D and 15S of the signal accumulation capacitor 15 may be of N type, while the source region 13S and the drain region 13D of the switching transistor 13 may be of P type.

[0052] Moreover, instead of using the semiconductor substrate directly as the semiconductor base and forming the source region and the drain region of the switching transistor and the semiconductor regions for constituting the signal accumulation capacitors in the semiconductor base, a configuration may be adopted in which, for example, a semiconductor base of P type is formed on a semiconductor substrate of N type, and a source region and a drain region of N type for constituting the switching transistor and semiconductor regions of P type for constituting the signal accumulation capacitor are formed in the semiconductor base of the P type.

<Example useful for understanding the invention : Fig. 3>

[0053] Fig. 3 illustrates a reflection type liquid crystal display apparatus not according to the present invention which comprises as a semiconductor device portion a semiconductor device not according to the present invention.

[0054] In this example useful for understanding the invention, the switching transistor 13 is configured in the same manner as those in the embodiments shown in Figs. 1 and 2. However, unlike in the embodiments shown in Figs. 1 and 2, the signal accumulation capacitor 15 has a configuration in which an electrode 15G is formed on a region, adjacent to the drain region 13D of the switching transistor 13, of the semiconductor substrate (semiconductor base) 11, with a thin insulating layer 12b therebetween which constitutes a part of the insulating layer 12. With an appropriate potential impressed on the electrode 15G, a channel 15c is formed at a portion beneath the electrode 15G adjacent to the drain region 13D, and a capacitance is formed.

[0055] In this example useful for understanding the invention, further, a high-concentration bias semiconductor region 17 of the same first conduction type as that of the semiconductor substrate 11 (namely, of P type where the semiconductor substrate 11 is of P type), for impressing a bias potential such as the earth potential on the semiconductor substrate 11, is formed in the semiconductor substrate 11 on the basis of each unit region for constituting a pixel Px.

[0056] Besides, on an insulating layer 14 formed on the insulating layer 12, a scan line 21 is formed in connection with the gate electrode 13G of the switching transistor 13, a signal line 23 is formed in connection with the source region 13S of the switching transistor 13, and a bias electrode 27 is formed in connection with the electrode 15G of the signal accumulation capacitor 15 and the bias semiconductor region 17. On an insulating layer 16 formed on the insulating layer 14, a reflection electrode 19 for constituting a pixel electrode is formed in

connection with the drain region 13D of the switching transistor 13.

[0057] A drive circuit is so constituted that, as shown in Fig. 5, with the bias electrode 27 earthed, with the earth potential impressed on the electrode 15G of the signal accumulation capacitor 15 and the bias semiconductor region 17, and with a predetermined potential impressed on the counter transparent electrode 31 functioning in common for each pixel, the scan lines 21 are sequentially selected by a scan line drive circuit, and a predetermined potential is impressed on the gate electrode 13G of the switching transistor 13 for the pixel connected to the scan line 21 thus selected, whereby the switching transistor 13 for the pixel under consideration is turned ON, and a signal voltage is impressed on the source region 13S of the switching transistor 13 for the pixel under consideration through a signal line 23 by a signal line drive circuit, whereby a signal charge is accumulated in the capacitance of the signal accumulation capacitor 15 for the pixel under consideration through the drain region 13D of the switching transistor 13 for the pixel under consideration.

[0058] The signal charge thus accumulated is impressed on the reflection electrode 19 for the pixel under consideration, whereby an image is displayed on the reflection type liquid crystal display apparatus 1, in the same manner as in the embodiments shown in Figs. 1 and 2.

[0059] In the reflection type liquid crystal display apparatus 1 and the semiconductor device portion 10 according to the comparative example shown in Fig. 3 constituted as above-described, a semiconductor region for constituting the signal accumulation capacitor 15 is not formed in the semiconductor substrate 11 separately from the drain region 13D of the switching transistor 13. Therefore, even though the bias semiconductor region 17 is formed on the semiconductor substrate 11, the area of the pixel Px can be reduced, and the number of pixels which can be formed in a predetermined size can be enlarged.

[0060] Incidentally, a bias potential different from the earth potential may be impressed on the electrode 15G of the signal accumulation capacitor 15 and the bias semiconductor region 17. In addition, bias potentials different from each other may be impressed respectively on the electrode 15G and the bias semiconductor region 17.

[0061] Besides, on the contrary to the comparative example shown in Fig. 3, the semiconductor substrate (semiconductor base) 11 and the bias semiconductor region 17 may be of N type, while the source region 13S and the drain region 13D of the switching transistor 13 may be of P type.

[0062] Furthermore, instead of using the semiconductor substrate directly as the semiconductor base and forming the source region and the drain region of the switching transistor and the bias semiconductor region in the semiconductor base, a configuration may be adopted in which, for example, a semiconductor base of P type is formed on a semiconductor substrate of N type, and a source region and a drain region of N type for constituting the switching transistor and a bias semiconductor region of P type are formed in the semiconductor base of the P type.

[Embodiment of Reflection Type Liquid Crystal Projector: Fig. 6]

[0063] The reflection type liquid crystal display apparatus according to the present invention, constituted as those in the above-described embodiments, can be used, for example, for a reflection type liquid crystal projector (projection type display apparatus).

[0064] Fig. 6 illustrates an embodiment of the reflection type liquid crystal projector according to the present invention, using the reflection type liquid crystal display apparatus according to the present invention.

[0065] In the reflection type liquid crystal projector 2 according to this embodiment, non-polarized white light as parallel rays having a uniform intensity distribution in a predetermined region on a plane orthogonal to the center of light beam is emitted from an illumination unit 3 comprising a white light source therein.

[0066] The light beam thus emitted is incident on a polarized light beam splitter 4, where it is split into a light beam of S polarized light reflected by the polarized light beam splitter 4, and a light beam of P polarized light transmitted through the polarized light beam splitter 4. The light beam of S polarized light reflected by the polarized light beam splitter 4 is incident on a red reflector 5, where red light in the light beam of S polarized light is reflected by the red reflector 5, whereas green light and blue light are transmitted through the red reflector 5. Further, the green light and blue light transmitted through the red reflector 5 are incident on a blue reflector 6, where the blue light is reflected by the blue reflector 6, whereas the green light is transmitted through the blue reflector 6.

[0067] Then, the red light reflected by the red reflector 5 is incident on a reflection type liquid crystal display apparatus 1R for red, the green light transmitted through the blue reflector 6 is incident on a reflection type liquid crystal display apparatus 1G for green, and the blue light reflected by the blue reflector 6 is incident on a reflection type liquid crystal display apparatus 1B for blue.

[0068] The reflection type liquid crystal display apparatuses 1R, 1G, and 1B are each a reflection type liquid crystal display apparatus according to the present invention, which is constituted as in the embodiment shown in Fig. 1, Fig. 2 or in the example useful for understanding the invention shown in Fig. 3, and in which image data are written by red, green, and blue picture signals (color signals), respectively.

[0069] The red light incident on the reflection type liquid crystal display apparatus 1R, the green light incident on the reflection type liquid crystal display apparatus 1G, and the blue light incident on the reflection type liquid crystal display apparatus 1B are modulated respectively by the reflection type liquid crystal display apparatuses

1R, 1G, and 1B based on the picture signals, are then reflected, and again combined with each other by the red reflector 5 and the blue reflector 6. Of the modulated red, green, and blue light beams thus re-combined, the P polarized light component is transmitted through the polarized light beam splitter 4 as image light, which is enlargedly projected on a screen 8 by a projection lens 7.

[0070] In the reflection type liquid crystal projector 2 according to this embodiment, the area of each pixel in the reflection type liquid crystal display apparatuses 1R, 1G, and 1B can be reduced, and the number of pixels which can be formed in a predetermined size can be enlarged, as described above. Therefore, where the reflection type liquid crystal display apparatuses 1R, 1G, and 1B are manufactured in a predetermined size, the number of the pixels in the reflection type liquid crystal display apparatuses 1R, 1G, and 1B can be enlarged, and a high-resolution image can be projected on the screen 8. On the other hand, where the reflection type liquid crystal display apparatuses 1R, 1G, and 1B each comprise a predetermined number of pixels, the size of the reflection type liquid crystal display apparatuses 1R, 1G, and 1B can be reduced, and, hence, the size of the reflection type liquid crystal projector 2 can be reduced.

[0071] Incidentally, the reflection type liquid crystal projector according to the present invention is not limited to the one shown in the figure. It suffices for the reflection type liquid crystal projector to comprise an illumination optical system for emitting the light from a white light source in the form of a light beam having a uniform intensity distribution in a predetermined region on a plane orthogonal to the center of the light beam, a decomposing optical system for splitting the thus emitted light beam into a plurality of color light beams such as red, green and blue light beams, reflection type liquid crystal display apparatuses according to the present invention on which the thus split color light beams are respectively incident, a combining optical system for combining color image light beams emitted from the reflection type liquid crystal display apparatuses for the colors, and a projection optical system for projecting the combined image light on a screen. Besides, the reflection type liquid crystal projector may be constituted by use of a single-plate reflection type liquid crystal display apparatus, in place of the decomposing optical system and the combining optical system. Furthermore, a back projection type may be constituted, instead of the front projection type as in the embodiment shown in Fig. 6.

[0072] As has been described above, according to the present invention, it is possible to realize a reduction in the area of each pixel without degrading noise resistance.

Claims

1. A semiconductor device comprising a switching transistor (13) and a signal accumulation capacitor (15) on a semiconductor base (11) of a first conduction type in each unit area constituting a pixel, wherein
said switching transistor (13) comprises a drain region (13D) and a source region (13S) connected to a signal line (23), both of which regions are of a second conduction type different from the first one and are formed in said semiconductor base (11), and a gate electrode (13G) formed on the semiconductor base (11) at a position between said source region (13S) and said drain region (13D), with an insulating layer (12a) arranged between the gate electrode (13G) and the semiconductor base (11), said gate electrode (13G) being connected to a scan line (21),
said signal accumulation capacitor (15) comprises two semiconductor regions (15D, 15S) of said first conduction type formed in said semiconductor base (11), and an electrode (15G) formed on the semiconductor base (11) at a position between said two semiconductor regions (15D, 15S), with an insulating layer (12G) arranged between the electrode (15G) of the signal accummulation capacitor (15) and the semiconductor base (11); and
a reflection electrode (19) for constituting a pixel electrode is formed so as to be connected to said drain region (13D) of said switching transistor (13) and said electrode (15G) of said signal accumulation capacitor (15),
wherein said two semiconductor regions (15D, 15S) of said signal accumulation capacitor (15) are connected to a bias electrode (27), and serve also as bias semiconductor regions of said semiconductor base (11).

2. A semiconductor device as set forth in claim 1, wherein
a further bias semiconductor region (17) of said first conduction type is formed in said semiconductor base (11), separately from said semiconductor regions (15D, 15S) of said signal accumulation capacitor (15).

3. A reflection type liquid crystal display apparatus (1) comprising a liquid crystal layer (33) formed between a surface provided with said reflection electrode (19) of a semiconductor device as set forth in any of claims 1 to 2, and a surface, provided with a counter transparent electrode (31) functioning in common for each pixel, of a counter transparent substrate (32) disposed opposite to said semiconductor device.

4. reflection type liquid crystal projector comprising a reflection type liquid crystal display apparatus (1) as set forth in claim 3, arranged to modulate light emitted from light source (3) based on a picture signal by said reflection type liquid crystal display apparatus (1), and to project the light outputted through the modulation through a projection lens (7).

Patentansprüche

1. Halbleitereinrichtung mit einem Schalttransistor (13) und einem Signalakkumulationskondensator (15) auf einer Halbleiterbasis (11) eines ersten Leitfähigkeitstyps, welche in jeder Flächeneinheit ein Pixel bilden,
wobei
der Schalttransistor (13) einen Drainbereich (13D) und einen Sourcebereich (13S), die mit einer Signalleitung (23) verbunden sind, wobei beide Bereiche vom zweiten Leitfähigkeitstyp sind, der verschieden ist vom ersten, und wobei beide in der Halbleiterbasis (11) ausgebildet sind, sowie eine Gateelektrode (13G) auf der Halbleiterbasis (11) an einer Stelle zwischen dem Sourcebereich (13S) und dem Drainbereich (13D) aufweist, wobei eine Isolationsschicht (12A) zwischen der Gateelektrode (13G) und der Halbleiterbasis (11) angeordnet ist, wobei die Gateelektrode (13G) mit einer Abtastleitung (21) verbunden ist,
der Signalakkumulationskondensator (15) zwei Halbleiterbereiche (15D, 15S) vom ersten Leitfähigkeitstyp, die in der Halbleiterbasis (11) ausgebildet sind, sowie eine Elektrode (15G) aufweist, die auf der Halbleiterbasis (11) an einer Stelle zwischen den zwei Halbleiterbereichen (15D, 15S) ausgebildet ist, wobei eine Isolationsschicht (12b) zwischen der Elektrode (15G) des Signalakkumulationskondensators (15) und der Halbleiterbasis (11) angeordnet ist, und
eine Reflexionselektrode (19) zum Bilden einer Pixelelektrode so ausgebildet ist, um mit dem Drainbereich (13D) des Schalttransistors (13) und der Elektrode (15G) des Signalakkumulationskondensators (15) verbunden zu sein,
wobei die zwei Halbleiterbereiche (15D, 15S) des Signalakkumulationskondensators (15) mit einer Biaselektrode (27) verbunden sind und als Biashalbleiterbereiche der Halbleiterbasis (11) dienen.

2. Halbleitereinrichtung nach Anspruch 1,
wobei ein weiterer Biashalbleiterbereich (17) vom ersten Leitfähigkeitstyp in der Halbleiterbasis (11) separat von den Halbleiterbereichen (15D. 15S) des Signalakkumulationskondensators (15) ausgebildet ist.

3. Flüssigkristallanzeigevorrichtung (1) vom Reflexionstyp,
mit einer Flüssigkristallschicht (33), welche zwischen einer Fläche, die mit einer Reflexionselektrode (19) einer Halbleitereinrichtung nach einem der Ansprüche 1 bis 2 ausgebildet ist, und einer Fläche eines transparenten Gegensubstrats (32), welches der Halbleitereinrichtung gegenüber liegt, vorgesehen ist, wobei die Fläche die mit einer transparenten Gegenelektrode (31) ausgebildet ist, welche für jedes Pixel gemeinsam funktioniert.

4. Flüssigkristallprojektor vom Reflexionstyp,
mit einer Flüssigkristallanzeigevorrichtung (1) vom Reflexionstyp nach Anspruch 3, welche so ausgebildet ist, von einer Lichtquelle (3) auf der Grundlage eines Bildsignals durch die Flüssigkristallanzeigevorrichtung (1) vom Reflexionstyp ausgesandtes Licht zu modulieren und das durch die Modulation ausgegebene Licht durch eine Projektionslinse (7) zu projizieren.

Revendications

1. Dispositif à semi-conducteur comprenant un transistor de commutation (13) et un condensateur d'accumulation de signaux (15) sur une base semi-conductrice (11) d'un premier type de conduction dans chaque zone unitaire constituant un pixel, dans lequel
ledit transistor de commutation (13) comprend une région drain (13D) et une région source (135) reliées à une ligne de signal (23), les deux régions étant d'un second type de conduction différent du premier et étant formées dans ladite base semi-conductrice (11), et une électrode grille (13G) formée sur la base semi-conductrice (11) dans une position située entre ladite région source (13S) et ladite région drain (13D), une couche isolante (12a) étant disposée entre l'électrode grille (13G) et la base semi-conductrice (11), ladite électrode grille (13G) étant reliée à une ligne de balayage (21) ;
ledit condensateur d'accumulation de signaux (15) comprend deux régions semi-conductrices (15D, 15S) dudit premier type de conduction formées dans ladite base semi-conductrice (11), et une électrode (15G) formée sur la base semi-conductrice (11) dans une position située entre lesdites deux régions semi-conductrices (15D, 15S), une couche isolante (12b) étant disposée entre l'électrode (15G) du condensateur d'accumulation de signaux (15) et la base semi-conductrice (11) ; et
une électrode de réflexion (19) servant à constituer une électrode pixel est formée de manière à être reliée à ladite région drain (13D) dudit transistor de commutation (13) et à ladite électrode (15G) dudit condensateur d'accumulation de signaux (15),
dans lequel lesdites deux régions semi-conductrices (15D, 15S) dudit condensateur d'accumulation de signaux (15) sont reliées à une électrode de polarisation (27), et servent également de régions semi-conductrices de polarisation de ladite base semi-conductrice (11).

2. Dispositif à semi-conducteur selon la revendication 1, dans lequel
une autre région semi-conductrice de polarisation (17) dudit premier type de conduction est formée

dans ladite base semi-conductrice (11), séparément desdites régions semi-conductrices (15D, 15S) dudit condensateur d'accumulation de signaux (15).

3. Appareil d'affichage à cristaux liquides à réflexion (1) comprenant une couche de cristaux liquides (33) formée entre une surface pourvue de ladite électrode de réflexion (19) d'un dispositif à semi-conducteur selon les revendications 1 à 2, et une surface pourvue d'une contre-électrode transparente (31) fonctionnant en commun pour chaque pixel, d'un contre-substrat transparent (32) disposé à l'opposé dudit dispositif à semi-conducteur.

4. Projecteur à cristaux liquides à réflexion comprenant un appareil d'affichage à cristaux liquides à réflexion (1) selon la revendication 3, conçu pour moduler la lumière émise par une source de lumière (3) sur la base d'un signal d'image par ledit appareil d'affichage à cristaux liquides à réflexion (1), et pour projeter la lumière sortie par le biais de la modulation à travers une lentille de projection (7).

Fig.1

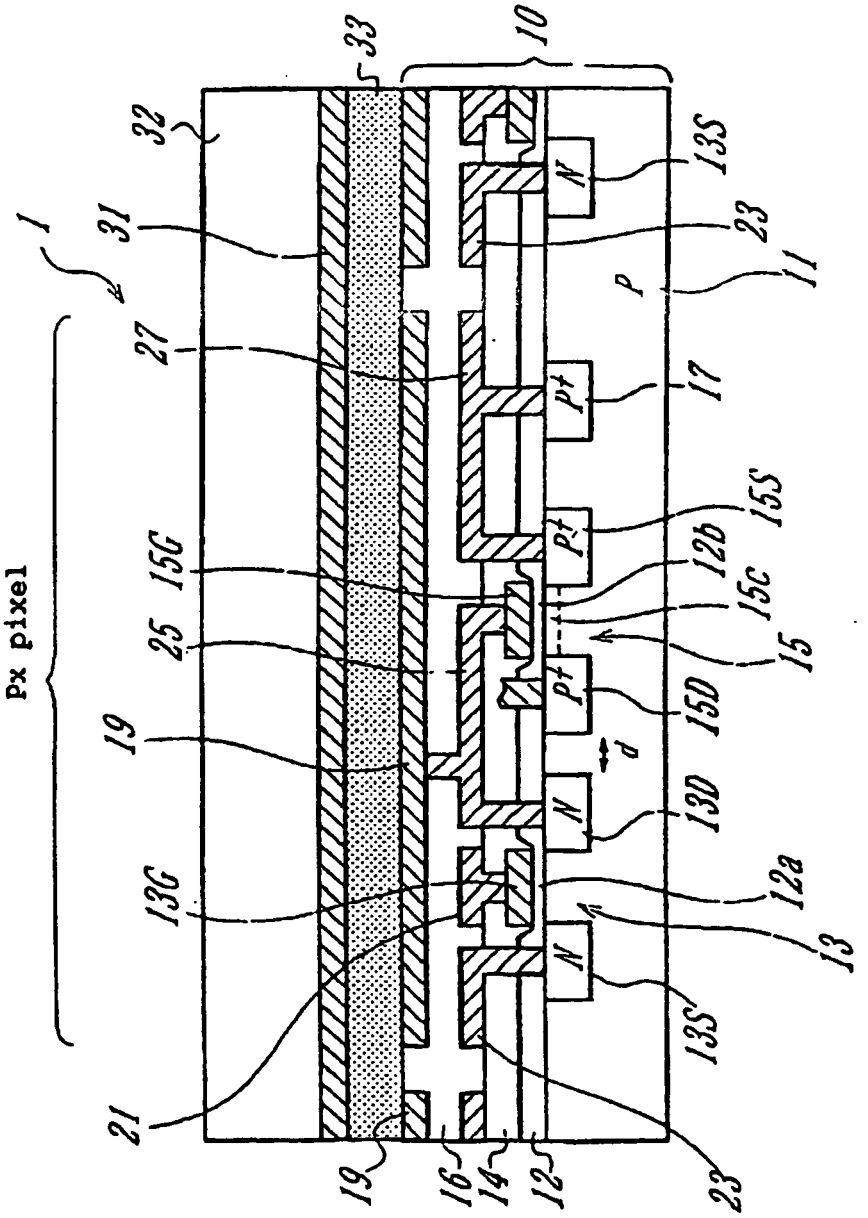

Px pixel
1
10
11
12
12a
12b
13
13G
13D
13S
14
15
15c
15D
15G
15S
16
17
19
21
23
25
27
31
32
33
d
P
N
P+

Fig.2

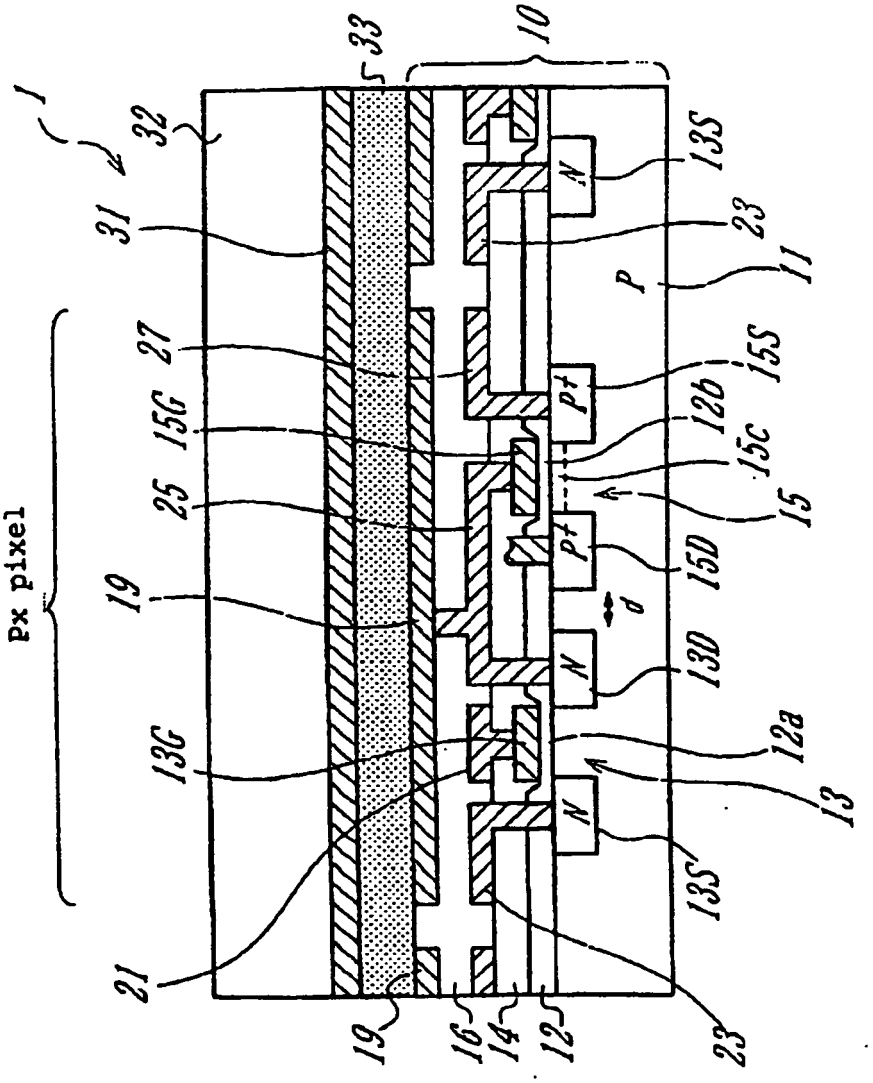

1
32
33
10
31
27
15G
25
19
13G
21
Px pixel
13S
23
11
P
15S
12b
15c
15
15D
d
13D
12a
13
13S
23
19
16
14
12
N
P+

Fig.3

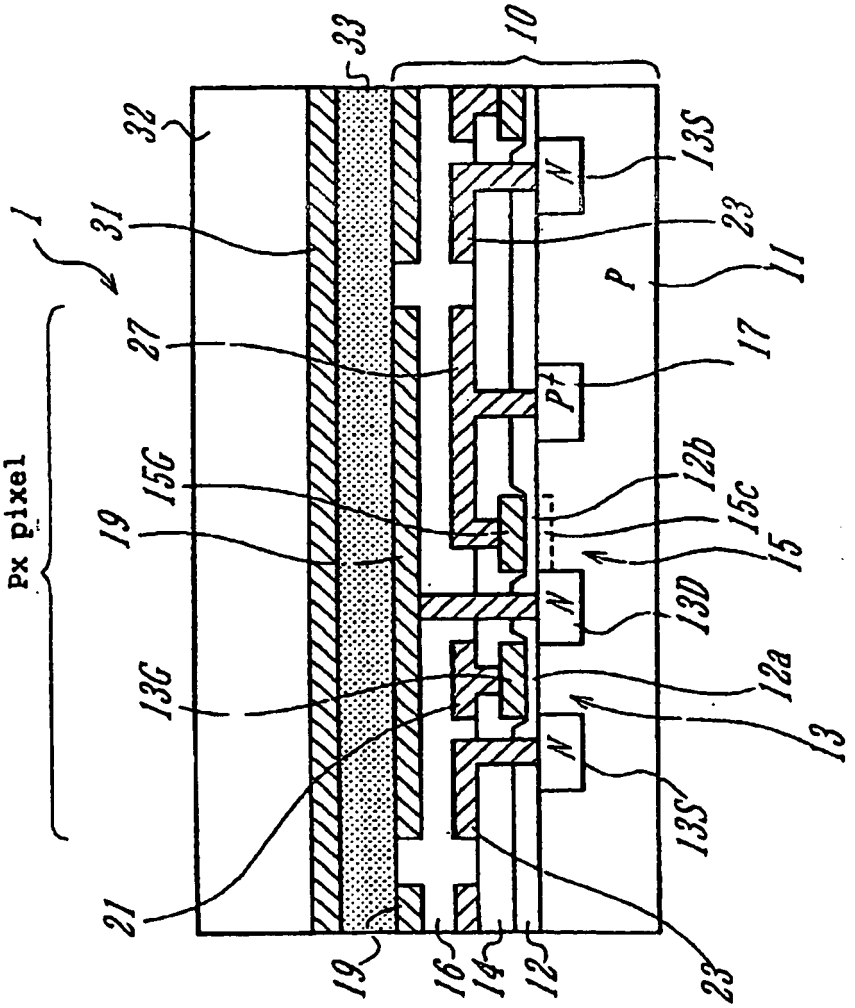

Px pixel
1
10
11
12
12a
12b
13
13D
13G
13S
14
15
15c
15G
16
17
19
21
23
27
31
32
33
N
P
P+

Fig.4

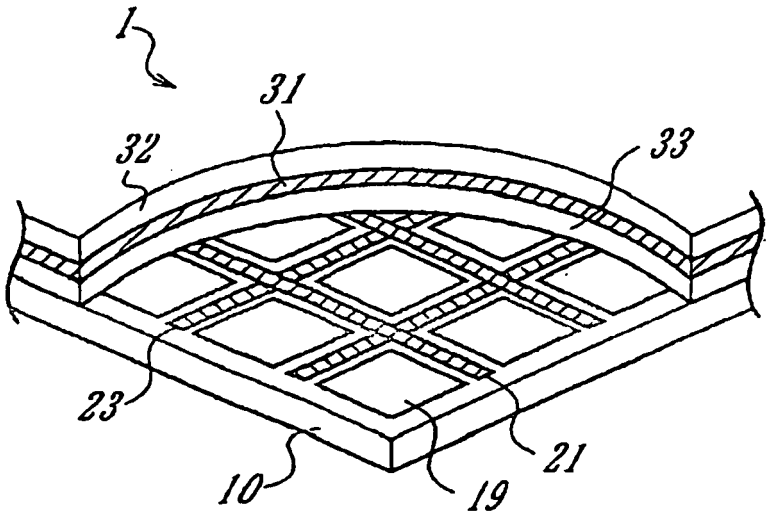

1
31
32
33
23
21
10
19

Fig.5

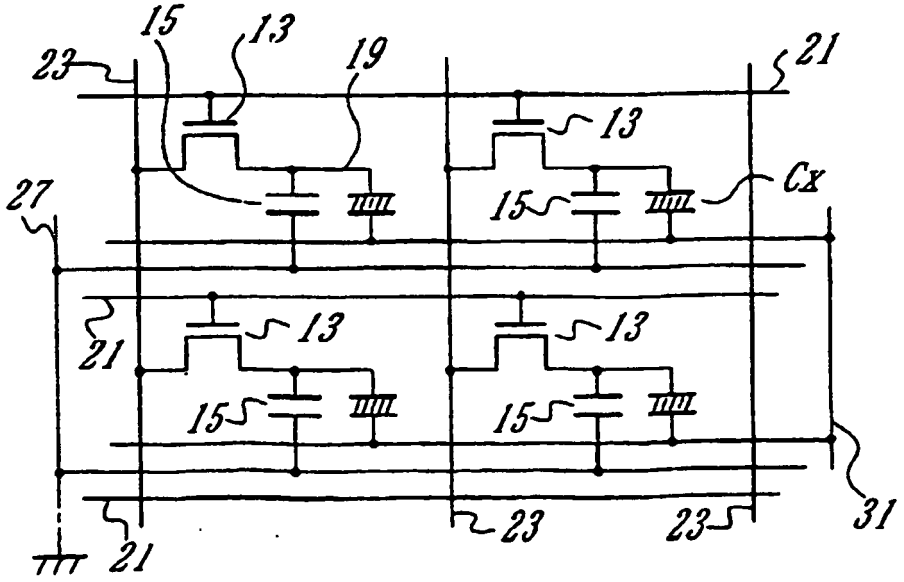

15
13
19
23
21
13
Cx
27
15
21
13
13
15
15
31
23
23
21

Fig.6

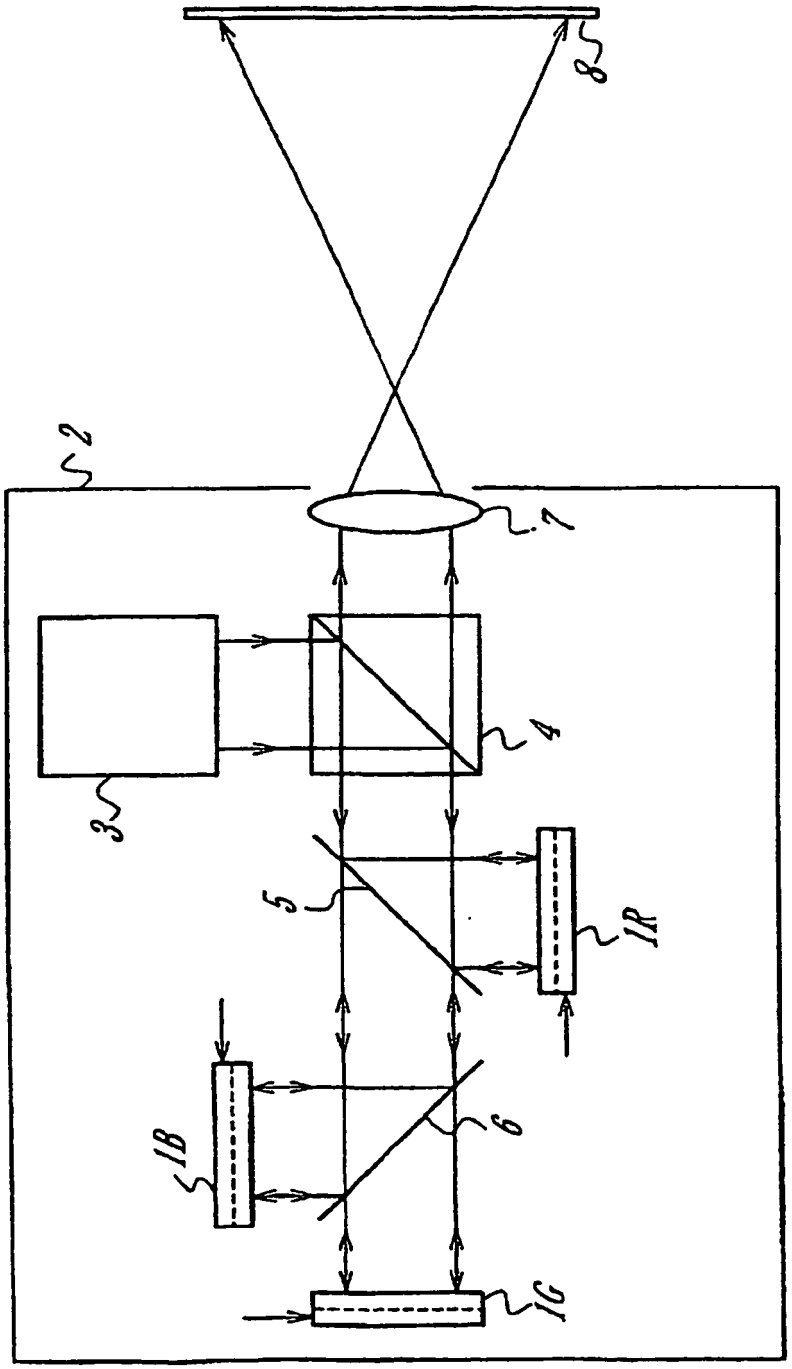
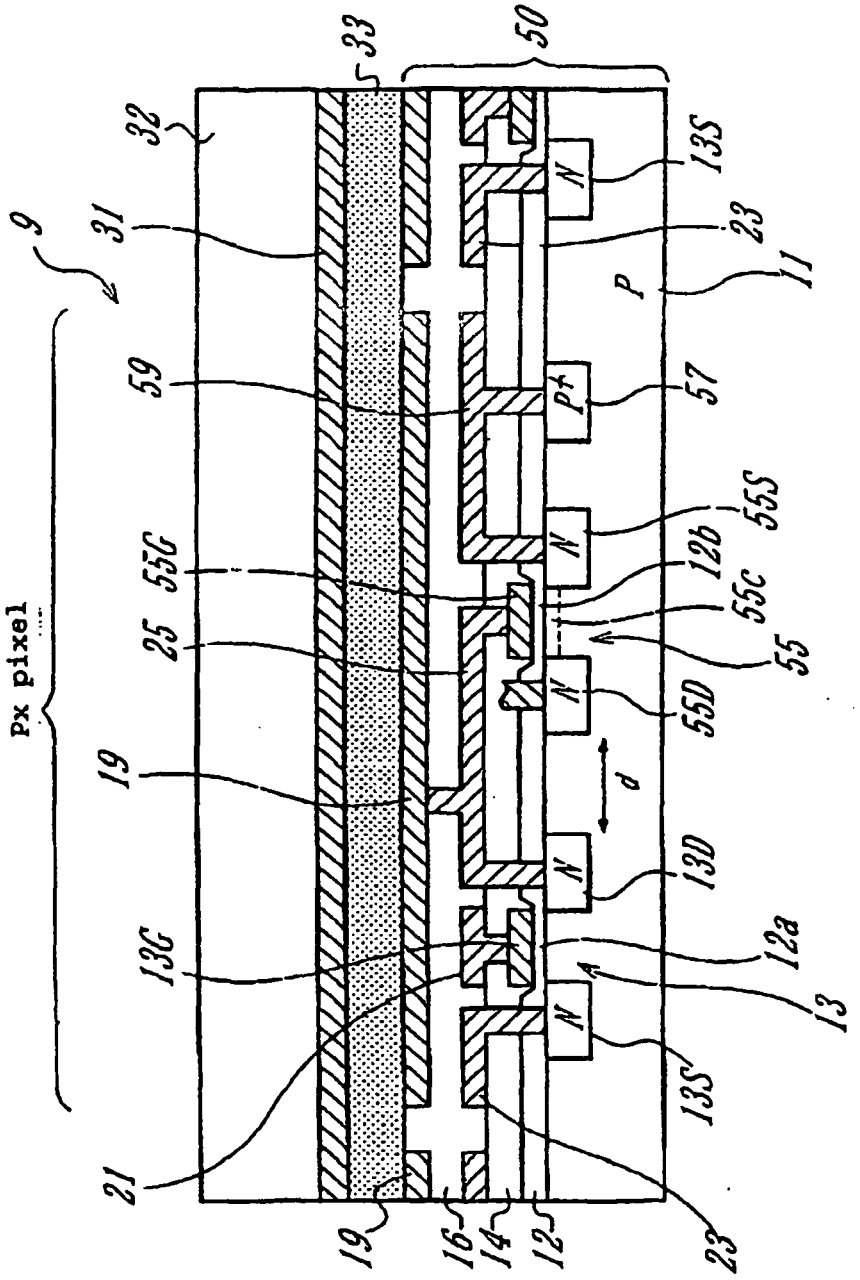


Fig.7


Px pixel
9
31
32
33
50
59
25
55G
19
13G
21
13S
23
11
P
57
P+
55S
12b
55c
55
55D
d
13D
12a
13
A
N
16
14
12

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